VIRTUAL REALITY VIEWING SYSTEM AND METHOD

Field of the Invention

The present invention relates to the field of computer graphic imaging, and more particularly the field of virtual reality viewing.

Background Of The Invention

A virtual reality system generally consists of a head mounted graphic display connected to a computer, along with a method for communicating to the computer, the exact direction in which the person wearing the head mounted display is facing. The purpose of a virtual reality system is to create for the person wearing the display, the illusion of being in a different location. In order to achieve this, the computer displays the virtual environment as if it were being viewed from both the position and the direction that the person is 1ooking. As the person moves its head and the head mounted display, the computer continuously changes the image being viewed to show the virtual environment from the current perspective. Thus, it appears to the person wearing the display that they are actually in the virtual environment and are looking around.

A variation of this approach can be called telepresence. In this system, instead of a computer generating the image, the image is generated by a controlled, movable video camera. As the person wearing the display moves its head, the camera, in a remote location, moves correspondingly, showing the location from the orientation of the remote viewer. This system thus makes it appear to the viewer that it is actually in the remote location and looking around. Both of these systems have a serious drawback that reduces the effectiveness of the illusion that the person wearing the display is actually in a different location. The problem is latency. Latency, in this context, is defined as the time required to calculate the perspective and position from which the viewer is facing, transmit this information to the computer or the remote camera,

generate the view from the new orientation, and transmit that view back to the display. Should the latency be long enough, the viewer may be facing a slightly different direction when the image from the earlier sampling is finally displayed. The effect is to make the environment, which should be positionally stable, seem to move. This effect can be troubling and may cause disorientation in some users.

In an effort to overcome this problem, faster sensors, computers and transmission methods have been employed. However, even a small amount of latency reduces the effectiveness of the system. As long as any amount of latency exists, the illusion will not be complete.

Summary of the Invention

The present invention serves to overcome the deficiencies of prior art systems by providing a means for presenting the image to the person wearing the display, in such a manner as to display the selected environment from the exact perspective from which the viewer is facing, any time, without latency, thus offering a realistic feeling of being immersed in the selected environment.

Instead of reading the current position of the viewer's head and creating an image from that perspective, the present invention uses several readings from the head position sensor to determine the direction, velocity and acceleration of the viewer's head. Using this information, the system calculates the direction in which the viewer will be looking when the image finally reaches the display and creates the image from that direction rather than from the direction that the viewer was facing when the sensor readings were taken.

When using a remote camera to create the image, the camera is moved into the position that corresponds directly with the perspective point from which the viewer will be facing, based

on the calculations of direction, velocity and acceleration, when the image from the camera reaches the display.

When compared to the speed of electronic data processing or the slew rates of modern servo systems, the human body moves and accelerates at a very slow rate. It is thus not only possible to measure and calculate the future position of the viewer's head, but is equally possible to move a camera to the new position fast enough to generate a realistic view from that anticipated position.

Brief Description of the Drawings

Figure 1 is a graphic representation of 3 real-time-phased d/t curves; and

Figure 2 is a flow diagram exemplifying the process of rendering a viewing frame in a real-time virtual reality system.

Detail Description of the Preferred Embodiments of the Invention

A virtual reality system generally comprises a display / sensor apparatus that is worn by a viewer and connected to a computer system capable of manipulating the position and perspective of the image viewed in the display to correspond with the position from which it is being viewed. Connected to such apparatus are one or more position encoding devices providing positional feedback representative of the angular displacement of various axes of rotation. Certain systems may also provide representations of various linear displacements in the vertical and horizontal directions.

There are numerous methods in use for providing positional feedback to the host computer. One method utilizes ultrasonic sensors to track position by triangulation, based on the varying time lag produced between different sets of emitters and receivers. Another method utilizes sets of coils, pulsed to produce magnetic fields. Magnetic sensors then determine

position by measuring the varying strength and angles of the magnetic fields. Another typical method utilizes mechanical photo - optic pulse encoders that provide a plurality of pulses corresponding with a change of displacement between the encoder and the device to which it is attached.

Based on the aforementioned descriptions, it is evident that there are a number of different types of sensors and encoding devices that are suitable for providing positioning information to a computer, all of which are well known in the art. Regardless of the fact that the methods and devices are diverse in nature, each serves the primary purpose of providing a positioning signal to the host computer.

The present invention utilizes a spline path calculated from a distance vs. time curve to generate the anticipated position of the viewer in all axes, and then computes an anticipated perspective view, transmitting it to the display slightly ahead of the viewer's current perspective and position. For the purpose of description, the photo - optic pulse encoder type sensor will be exemplified herein. It is to be understood, .however, that a signal derived from virtually any available sensing device may be processed to generate a distance vs. time curve for the purpose of deriving a probable spline path.

As the viewer moves in various directions, the displacement of each encoder changes accordingly, producing a stream of pulses. The number of pulses produced corresponds proportionally with the movement of the viewer. Such pulses are counted for specific time increments equaling approximately 60 milliseconds. The number of pulses counted in each 60-millisecond increment for a given axis represents the amount of movement that occurred in that axis over a predetermined time period. The velocity of each axis movement can thus be computed based on the distance traveled over a given time period.

There is provided in Figure 1, a displacement vs. time (d/t) graph representing (d/t) the curves of three rotary axes, designated $a_{d/t}$, $b_{d/t}$, and $c_{d/t}$ respectively. The displacement measurement of each axis is plotted in unison over three consecutive time periods. The speed at which each axis moves through a given time period is not necessarily constant, but will in all probability, change on a nonpredictable, somewhat exponential scale. Based on the displacement changes plotted at p_0 p_1 p_2, and p_3, a spline path is generated for each axis. The point designated $P_{probable}$ is the anticipated position of the corresponding axis based on the derivative of the spline. The computer then manipulates the position and perspective of the image presented to the viewer based on the anticipated position of each axis, as represented by the point $P_{probable.}$

Referring to the flow chart provided in Figure 2, as a viewer moves away from the current viewing perspective, a signal comprising sequentially increasing pulse counts is generated as at 101 The signal is read and plotted by the host computer at 60 millisecond intervals at 102. A spline representing the probable axis path is formulated based on the magnitude of the signal at three consecutive points in time as at 103. The probable future viewing perspective is formulated based on the spline path as at 104. A viewing frame is then assembled and rendered to the viewer based on the probable future viewing perspective 105. By generating the image slightly ahead of its actual occurrence, the latency created by data acquisition and computation time is overcome, thus allowing the viewer to view the image in real time.

From the foregoing detailed description, it will be evident that there are a number of changes, adaptations and modifications of the present invention that come within the province of those persons having ordinary skill in the art to which the aforementioned invention pertains.

However, it is intended that all such variations not departing from the spirit of the invention be considered as within the scope thereof as limited solely by the appended claims.